MANAGEMENT OF CERCOSPORA LEAF SPOT OF MUNGBEAN (*Vigna radiata*) THROUGH BOTANICALS

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CERTIFICATE

This is to certify that thesis entitled, **"Management of Cercospora Leaf Spot of Mungbean (*Vigna radiata*) through Botanicals"** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE in PLANT PATHOLOGY*****,** *embodies the result of a piece of bona fide research work carried out by* ***Md. Nasir Uddin, Roll No. 00121, Registration No. 02191*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that any help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated:
Place: Dhaka, Bangladesh

(Dr. Md. Abu Bakr)
Project Director
Strengthening of Pulse and Oilseeds Research in Bangladesh, BARI
Supervisor

Dedicated TO
MY
Late Nephew (Rakib) Who
Died in Blood Cancer

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ABSTRACT

The present experiment was conducted for management of Cercospora leaf spot of mungbean through botanicals. The experiment comprised of 7 treatments such as T_1 = Neem leaves extract (1:4 w/v); T_2 = Garlic cloves extract (1:5 w/v); T_3 = Biskatali leaves extract (1:4 w/v); T_4 = Alamanda leaves extract (1:6 w/v); T_5 = Arjun leaves extract (1:4 w/v); T_6 = Debdaru leaves extract (1:5 w/v) and T_7 = Untreated (control). The experiment was laid out in Randomized Complete Block Design. Data on disease incidence, severity, yield contributing characters and yield of mungbean were recorded. The highest (13.42% infected plant) disease incidence was recorded in treatment T_7 and the lowest (3.67% infected plant) disease incidence was recorded in treatment T_1 at 60 DAS and the highest (13.65) disease severity was recorded in treatment T_7 and the lowest (4.55) disease severity was recorded in treatment T_2 and T_3. The highest (13.45) number of inflorescence per plant was recorded in treatment T_1. The tallest (51.44 cm) plant was recorded in treatment T_1. The maximum number of bunches (8.56), number of pod per plant (26.81), length of pod (8.56 cm), number of seed per pod (12.64) and 1000 seed weight (27.33 g) was recorded in treatment T_1. The highest yield (1.51 kg/plot, 1.26 t/ha) also recorded in treatment T_1.

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INTRODUCTION

Mungbean (*Vigna radiata*), belongs to the family leguminosae and sub family papilionaceae, is one of the most important pulse crops having global economic importance as a dietary ingredient of the staple food in tropical and subtropical region. It is originated in South East Asia and widely grown in India, Pakistan, Bangladesh, Myanmar, Thailand, Philippines, China, Indonesia and parts of East and Central Africa, West Indies, America and Australia (Gowda and Kaul, 1982).

In Bangladesh, among pulses, mungbean ranks fourth in acreage, third in production and first in market price (BBS, 2006). The average yield of mungbean is 763.50 kg/ha in Bangladesh which is low compared to potential yield of this crop and to the average yield of other pulse growing countries (BBS, 2006). It contributes 6.5% of total pulse production of Bangladesh (BBS, 2006). It can fix atmosphere nitrogen through symbiotic relationship with soil bacteria and improve the soil fertility (Yadav *et al.*, 1994). It is an excellent source of proteins and minerals for most of the peoples of Bangladesh. Mungbean has been considered as a “poor men’s protein” (Mian, 1976). Apart from 26% protein, it also contains 51% carbohydrate, 10% moisture, 4% minerals and 3% vitamins (Khan, 1981).

There are various factors which are responsible for lower yield of mungbean in our country and among them diseases are considered to be the most important (Bakr and Rahman, 1998). A total of sixteen diseases of mungbean have been recorded (Fakir, 1983 and Bakr, 1993). Among the diseases Cercospora leaf spot is a serious disease of mungbean (Verma and Sandhu, 1992) and causes yield losses of upto 58% (Lal *et al*, 2001). It is widely distributed all over the country where mungbean is cultivated.

The causal organism is fungal pathogen belonging to the genus Cercospora. Several species have been reported to cause the diseases at different degree of severity. The important ones are *Cercospora cruenta*, *C. conescens*, *C. kikuchii*, *C. caracallae*. Among them *Cercospora cruenta* (Talukder, 1974) is the most prevalent species. The initial symptoms of the disease appear as water soaked spot on leaves. As spots become older may coalesce together causing enlarged dead area on the infected leaves. Heavy infection of *Cercospora* can cause mungbean plant premature defoliation. Sometimes the leaves may become malformed and wrinkled. Maturity was delayed in the diseased plants and flower and pod production are severely reduced. Seeds that developed on severely infected plants were small and immature (Poehlman, 1991).

Different approaches were tried to control Cercospora leaf spot, which included (i) spray of chemical insecticides, (ii) spray of different plant extracts (iii) use of resistant variety. All of the released variety of mungbean in Bangladesh was identified as a resistant variety but most of them severely affected varying from place to place.

Use of chemical to control a disease is the favorable means to our farmers till now. However, application of precise dose of the chemical to the field is a difficult job for them. Indiscriminate and long time use of chemicals affect the soil health. Harmful chemical substances enter into the food chain that ultimately causes serious health hazards. Eco-friendly management of plant diseases such as use of plant extracts has a great chance to save the beneficial soil microorganisms. Most of the plant extracts also cost effective and readily available near to the farmers timely.

Use of plant extract against plant diseases control is however a recent approach to plant diseases management and it has drawn the special attention of the plant pathologist all over the world. In Bangladesh, only a few attempts have been made to evaluate plant extracts against plant diseases (Ashrafuzzaman and Hossain, 1992; Hossain *et al*., 1993; Ashrafuzzaman and Khan, 1992; Suratuzzaman *et al*., 1994). Many researchers reported plant extracts having antifungal properties and thus

having potential to be used against many plant diseases. It would help to avoid environmental pollution caused by chemicals and thus become most rewarding one to our existing socio-economic conditions and environmental threat.

In the light of above back ground, the present piece of research work has been undertaken with the following objectives.

i. To asses the affect of Cercospora leaf spot infection on growth of mungbean.

ii. To find out the effect of different botanicals on the incidence and severity of the Cercospora leaf spot disease of mungbean

iii. To estimate the effect of different botanicals on yield and yield contributing characters of mungbean

REVIEW OF LITERATURE

Use of botanicals instead of chemicals fungicides is one of the recent approaches for plant disease control but it is not commonly practiced. The research work so far done in Bangladesh and else where is not adequate and conclusive. Nevertheless, some of the important and informative works and research findings related to the control through plant extract at home and abroad have been reviewed in this chapter.

Bulb extract of garlic was most effective against the major seed borne pathogen of Jute viz. *Macrophomina phaseolina*, *Botryodiplodia theobromae* and *Colletotrichum corchori* was observed by Ahmed and Sultana (1984). They reported that jute seeds treated with garlic paste increased seed germination and decreased the rate of post emergence seedling mortality over untreated control. The growth of jute plant was higher in treated plot than the control condition.

Dharam and Sharma (1985) observed that neem oil inhibited the growth of *Alternaria alternata* by 61% and 100% at 1% and 10% concentration, respectively in watermelon cultivation.

El-Shami *et al.*, (1986) observed that the antifungal property of garlic juice was also demonstrated against *Fusarium* wilt of watermelon caused

by *Fusarium oxysporum* f. sp. *niveum*. They also observed that garlic extract successfully inhibited spore germination and mycelial growth of fungus. But *in vitro* experiment, soaking water melon seeds in the extract gave better control of seedling infection than that of seed treatment with Benlate, Vitavax, Carboxin (captan + carboxin) or Thiram.

Assadi and Behroozin (1987) conducted an experiment to evaluate the efficacy of bulb extracts of onion and clove extracts of garlic against mycelial growth of *Fusarium* spp. and *Sclerotium cepivorum*. Garlic extract was found more active than that of onion in inhibiting growth of *Fusarium solani*, *Fusarium oxysporum* and *Fusarium acuminatum*.

Alice and Rao (1987) evaluated 31 plant extracts *in vitro* against *Drechslera oryzae* in rice using paper disc technique (inhibition zone technique) and found that maximum inhibition of *D. oryzae* was obtained with *Mentha piperita* followed by *Piper nigrum* seed extract and *Allium sativum* extract.

Chalfo and Carvalho (1987) compared the garlic extract and chemical fungicide Captafol in controlling mycelial growth of *Gibberella zeae* where most effective concentration being 8000 ppm for garlic extract and 10000 ppm for Captafol.

Singh and Dwivedi (1987) estimated that hyphal dry weight and sclerotia production of *Sclerotium rolfsii* Sacc. were significantly reduced by bark extracts of *Acacia arabia*. They evaluated bulb and leaf extracts of garlic and onion, leaf extracts of *Rauwolfia sarpentina*, *Lowsonia alba, Dutara stramonium*, *Solanum xarhocarpum*, *Calotropis procera, Eucalyptus globus*, *Emblica officinalis*, fruit extract of *Azadirachta indica* and rhizome extracts of turmeric and ginger against *Sclerotium rolfsii* and found that those extracts more or less effective in inhibiting the growth of the fungus.

Mishra *et al*. (1989) investigated the fungitoxic effect of lemon (*Citrus medica*) extract against *Aspergillus flavus* and found that the extract inhibited the fungus considerably.

Shetty *et al*. (1989) found that rice seeds soaked in 10, 20 and 30% extracts (w/v) of garlic bulb and rhizome of ginger significantly reduced seed-borne infection of *Trichoconiella* (*Alternaria*) *padwickii*.

Extract of pan (*Piper betel*) found to be effective against collar rot pathogen, *Thanatephorus cucumeris* (Lakshmonan *et al*., 1990). They also observed that garlic clove extract was most effective in inhibiting mycelial growth and spore germination of *Corynespora cassiicola*.

Miah *et al*. (1990) examined the efficacy of extract of eight different plant species against seed borne fungi of rice through eight ours seed soaking. Out of the plant species tested, extracts of *Allium sativum* and *Curcuma longa* reported to be promising.

Dubey and Dwivedi (1991) reported that fungistatic properties of extracts of leaves, bulb of onion and garlic and fruit, bark of *Allium cepa* against vegetative growth, *Sclerotia* variability of *Macrophomina phaseolina.* They observed that all the extracts inhibited growth but garlic bulb extract was more effective than other extracts employed in the tests.

Tewari and Mandakini (1991) reported that extract of *Piper betle*, *Ocimum sanctum*, *Nyctanthes arbortristis* and *Citrus lemon* were effective in reducing the radial growth of *Pyricularia oryzae*, *C. miyabeans* and *Rhizoctonia solani* in vitro, with extracts of *P. betle*, follwed by *O. sanctum* the most effective.

Thakhur *et al*. (1991) studied on extracts of medicinal plants against cotton pathogens *Myrothecium roridum*, *Alternaria tenuis* and *Xanthomonus campestris* pv. *malvacearum* showed that among the nine extract tested, *Punica granatum* and *Dutra metel* had the best antifungal and antibacterial activity against cotton pathogens.

Achimu and Schlosser (1992) carried out an experiment to find out the effect of neem seed extracts against downy mildew (*Plasmopara viticola*) of grapevine. They found that raw neem seed extract and commercial neem products had high (80-90%) antifungal properties against *Plasmopara viticola*.

Ashrafuzzaman and Hossain (1992) evaluated pudina (*Mentha viridis*) extract against *Bipolaris sorokiniana* and observed that the extract inhibited mycelial growth and spore germination. In the same work they found that extract of caster *(Ricinus communis*) and Dantha kalash (*Leucas aspera*) were inhibitory against mycelial growth and spore germination of *Bipolaris sorokiniana*.

Ashrafuzzaman and Khan (1992) evaluated Thankuni (*Hydrocotyl asiatica*), Mehedi (*Lawsonia alba*) and Duranta (*Duranta plumeiri*) against *Rhizoctonia solani* and found all the extracts effective in reducing mycelial growth and sclerotia formation effectively.

Fakir and Khan (1992) reported that garlic bulb extract was effective in controlling seed borne fungal pathogen of jute such as *Macrophomina phaseolina* and *Fusarium spp.* by seed treatment.

Hossain and Schlosser (1993) found neem seed extracts/cake effective against *Bipolaris sorokiniana*. The extract inhibited the growth of the

fungus and also reduced its pathogenecity on wheat leaves. Germination rate of wheat seeds increased after treatment with extracts of neem seed and cake.

Khan and Hossain (1993) observed that extracts of *Allium alba*, *Ricinus communis*, *Leomurus sibiricus* and *Metha viridus* completely inhibited spore germination of *B. sorokiniana* at 1:3 (w/v) dilution ratio.

Losses due to *C. canescens* in *Vigna radiata* were estimated in plot tests by Iqbal *et al*. (1995), using plant height, bunches/plant, pods/plant, pod length, seeds/pod, 1000 grain wt and yield/plant as parameters. Considerable decreases were recorded, reaching 61.24% in the case of yield/plant.

Mohanty (1995) demonstrated that leaf extract of neem was significantly effective causing 52.23% growth inhibition of *Phomopsis vexans*, the causal agent of phomopsis blight and fruit rot of brinjal.

Suratuzzaman (1995) performed an experiment with plant extracts to control seed borne *Colletotricum dematium* var. *truncatum*, *Macrophomina phaseolina* and *Cercospora kikuchi* of soyabean seed. Seed treatment with garlic and ginger extracts gave excellent control of pathogens.

Mohanty *et al*. (1995) observed that garlic bulb extract (1:1) and allamonda leaf extract sprays in the field reduced phomopsis blight and fruit rot by 66% and 75%, respectively.

Barman and Das (1996) carried out an experiment with seed treatment with carbofuran 3G at 3% (w/w) and organic amendments; neem [*Azadirachta indica*] cake, poultry manure and mustard oil cake each at 2 t/ha alone and in combined application of seed dressing followed by organic amendments at 1 t/ha each, were effective in improving plant growth characters and yield of green gram [*Vigna radiata*]. The number of galls, egg masses and final nematode populations of *M. incognita* were reduced over the untreated control. The best result was obtained with poultry manure applied at 2 t/ha followed by the combined application of seed dressing + neem cake at 1 t/ha.

Vigna radiata plants in pots, kept in the field, were protected against natural viral infections by spraying with leaf extract of *C. aculeatum*, together with soil amendment with dry leaf powder or fresh extract reported by Barman and Das (1996). Unsprayed plants developed severe symptoms of mungbean yellow mosaic by geminivirus while treated plants were either asymptomatic or showed only very mild symptoms. Soil treatment with dry leaf powder plus a fresh leaf extract spray was

effective in increasing yields through reductions in disease incidence and severity.

Hossain *et al*. (1997) demonstrated from their experiment that the extract of *Allium sativum* and *Lawsonia alba* showed marked effect in inhibiting the spore germination and mycelial growth of *Bipolaris sorokiniana* and pathogenicity to wheat leaves and *Nigella sativa* showed positive antifungal activity in reducing the pathogenicity of *Bipolaris sorokiniana* of wheat leaves.

Kurucheve and Padmavathi (1997) evaluated five selected plant products against *Pythium aphanidermatum*, the causal organism of damping off of chilli. Among them *Allium sativum* (garlic) bulb recorded the minimum mycelium growth (176 mg) followed by *Lawsonia inermis* leaf extract. Maximum percentage of seed germination, growth and vigour of chilli seedlings were observed with garlic bulbs.

Mahfuzul (1997) evaluated some plant extract viz. garlic (*Allium sativum*), ginger (*Zingiber officinale*), nisinda (*Vitex negundo*), Dolkalmi (*Ipomoea fistulosa*) and marigold (*Tagetes erecta*) against major seed borne fungal pathogens of chilli. Among the plant extracts garlic was found to be most effective followed by neem leaf. The garlic and neem leaf extracts at the dilution ratio of 1:1 were almost equally effective.

Khan (1999) studied the effect of plant extacts (Allamanda, Bel and Neem) for the mangemnt of phomopsis blight/fruit rot of eggplant in field condition by sparaying and observed that among the 3 plant extracts, allanmonda was most effective than bel and neem extract.

Rahman *et al*. (1999) observed that bishkatali (*Polygonum hydropiper*), garlic (*Allium sativum*), ginger (*Zingiber officinale*) and neem (*Azadirachta tenuis*) extracts were effective against seed borne infections by *Alternaria tenuis, Bipolaris sorokiniana*, *Curvularia lunata*, *Fusarium spp*. of wheat. However, garlic was found superior to ginger and neem.

Uttam *et al*. (2001) reported that these days neem products are being exploited for their pesticidal value but sometimes these products have some adverse effect on the germination of seeds. Keeping this in view, the experiment was planned to find out the non-toxic dose of neem products. Seeds of mungbean were coated with neem seed powder, Neemgold, Neemark, Fieldmarshal, Achook and Nimbecidine @ 5% and 10% w/w (v/w for liquid formulations). Coated seeds were tested for germination in moist sand and in moist filter paper. Germination percentage was calculated after one week of sowing and also after 14 days of sowing to observe the delayed germination, if any. It was found that germination was suppressed and delayed more in sand as compared with filter paper. All the neem based commercial formulations delayed

germination and it was more pronounced with 10% dose of the products than in case of 5% dose. It was revealed that for pesticidal purposes only the dose of 5% w/w would be preferred.

Dhutraj *et al* (2001) investigated that the efficacy of 2 antibiotics as seed treatment for the management of bacterial leaf spot disease of mung bean (caused by *Xanthomonas axonopodis* pv. *vignaeradiatae*) and urdbean [*Vigna mungo*] (caused by *X. axonopodis* pv. *phaseoli*). Seeds of mung bean (cultivars BM-4 and S-8) and urdbean (cultivars TAU-1 and TAU-9) were immersed in streptocycline and bactosan antibiotics solution of 100, 150, 200 and 250 ppm concentration for 10, 15, 20 and 25 minutes. Results indicated that yellow colonies of *Xanthomonas* spp. decreased as immersion time in antibiotics solution increased. Immersion of seeds for 25 minutes in concentration of 250 ppm solution of streptocycline and bactosan was effective in controlling the seedborne bacteria, followed by 20, 15 and 10 minutes immersion time. Streptocycline was more effective than bactosan antibiotics in controlling *Xanthomonas* spp.

In an experiment conducted by Shyam *et al*. (2004) during kharif season of 2000/01 and 2001/02, at Lucknow, Uttar Pradesh, India, the destructive yellow mosaic disease of mungbean (*Vigna radiata*), caused by mungbean yellow mosaic virus, was successfully controlled by the application of the aqueous root extract of Boerhaavia diffusa [*Boerhavia*

diffusa]. Treatments were administered weekly, as foliar sprays, at a concentration of 10%, commencing from the seedling stage. Six sprays of *B. diffusa* root extract were found most effective, as it considerably delayed symptom appearance, suppressed symptom severity and decreased disease incidence by 80-90%. This treatment also increased root nodulation, plant height, primary and secondary branches, pod formation and grain yield.

Chowdhury (2005) observed that highly infected/contaminated seed samples with seed borne fungi of rice, wheat, cosmos, zinnia, sunflower and radish were subjected to seed treatment with 1:0, 1:1, 1:5, 1:10 and 1:20 dilution of crude/nascent extract of garlic, datura and turmeric; 1:5, 1:10 and 1:20 dilution of commercially available oil extracts of neem, mahogany and Koromcha; hot water treatment for 15 minutes at 50^0C, 52^0C, 54^0C, 56^0C and 58^0C temperatures and chemical seed treatment with vitavax-200 @ 0.1%, 0.2% and 0.3% of the seed weight. Botanicals at all concentrations reduced the occurrence of mycoflora on the seed significantly and thereby increased seed germination. Some fungi were totally removed at 1:10 dilution of commercially available plant oil extract.

Hossain *et al.* (2005) reported that extract of different plant viz. bishkatali, vatpata, garlic, gagra, bitter gourd and neem were effective

against fungi associated with wheat seed. Out of six plant species, neem extract was turned up as superior among the selected extracts followed by garlic, bishkatali and vatapta.

Islam *et al*. (2006) evaluated eight plant extracts including Vitavax-200 against leaf spot of wheat. Among eight plant extracts onion, garlic, kalijira, ginger, bishkatali and neem extract showed statistically similar grain yield as of seed treatment with vitavax-200. Seed treatment with bishkatali extract increased 29.74% grain yield over untreated control.

MATERIALS AND METHODS

3.1 Experimental Site

The experiment was conducted in the farm of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, Bangladesh during the period from March to July 2007. The location of the experimental site is $23^0 74^/$ N latitude and $90^0 35^/$ E longitude with an elevation of 8.2 meter from the sea level (Anon., 1989).

3.2 Climate

The geographical situation of the experimental site was under the subtropical climate, characterized by three distinct seasons, the post rainy or cool season from November to February and the pre-monsoon period or hot season from March to April and monsoon period from May to October (Edris *et al*., 1979). Details of the metrological data of temperature (^{0}C), relative humidity (%), rainfall during the period of the experiment was collected from the Bangladesh Meteorological Department (Climate Division) and presented in Appendix I.

3.3 Characteristics of Soil

The soil of the experimental area was Red brown terrace soil and belongs to the Modhupur Tract (UNDP, 1988) under AEZ 28. The selected plot was medium high land and the soil series was Tejgaon (FAO, 1988). The

experimental site was a medium high land and pH of the soil was 5.6. The characteristics of the soil under the experimental plot were analyzed in the SRDI, Soil testing Laboratory, Khamarbari, Dhaka and details of the soil characteristics are presented in Appendix II.

3.4 Planting Materials

In this research work, the seeds of BARI moog-3 were used. Seeds were collected from Bangladesh Agricultural Research Institute, Joydebpur, Gazipur.

3.5 Treatment of the Experiment

There were seven different treatments which are as follows:

T_1 = Neem (*Azadirachta indica*) leaves extract (1:4 w/v)

T_2 = Garlic (*Allium sativum*) cloves extract (1:5 w/v)

T_3 = Biskatali (*Polygonum hydropiper*) leaves extract (1:4 w/v)

T_4 = Alamanda (*Allamanda cathertica*) leaves extract (1:6 w/v)

T_5 = Arjun (*Terminalia aurjuna*) leaves extract (1:4 w/v)

T_6 = Debdaru (*Polyalthea longifolia*) leaves extract (1:5 w/v)

T_7 = Untreated(control)

3.6 Collection of botanicals

Botanicals were collected from Bangladesh Agricultural Research Institute, Joydebpur, Gazipur.

3.7 Preparation of extract

The extracts were prepared by using the method of Ashrafuzzaman and Hossain, 1992. For preparation of extracts, collected leaves were weighted in an electric balance and then washed in the water. After washing the big leaves were cut into small pieces. For getting extract, weighted plant parts were blended and then distilled water was added into the jug of the blender. The pulverized mass was squeezed through 3 folds of fine cotton cloth. For getting 1:4 (w/v) ratio 400 ml of distilled water was added with 100 g plant parts, 1:5 (w/v) ratio 500 ml of distilled water was added with 100 g plant parts, 1:6 (w/v) ratio 600 ml of distilled water was added with 100 g plant parts.

3.8 Procedure of application of plant extract

Plant extracts were applied in the field as foliar spray. Spraying was done 3 times at 7 days interval.

3.9 Design and layout of the Experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. The layout of the experiment was prepared for distributing the treatment combinations in each plot of each block. There were 28 unit plots altogether in the experiment. The size of the plot was 4.0 m × 3.0 m. The distance between two blocks and two plots were 1.0 m and 0.5 m, respectively (Appendix III).

3.10 Preparation of the main field

The selected experimental plot was opened in the last week of March 2007 with a power tiller and was exposed to the sun for a week. After one week the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. Weeds and stubbles were removed and finally obtained a desirable tilth of soil for sowing seeds of mungbean. The experimental plot was partitioned into the unit plots in accordance with the experimental design.

3.11 Application of manure and fertilizers

Well decomposed cowdung was applied at the time of final land preparation. The sources of fertilizers used for N, P and K were urea (45 kg/ha), TSP (100 kg/ha), MP (58 kg/ha), respectively (BARI, 2004). The entire amounts of TSP, MP were applied during final land preparation. Only urea was applied in two equal installments at 20 and 30 DAS.

Neem (*Azadirachta indica*)

Garlic (*Allium sativum*)

Plate 1. Botanicals used to test antifungal activity against Cercospora

Biskatali (*Polygonum hydropiper*)

Allamanda (*Allamanda cathertica*)

Plate 2. Botanicals used to test antifungal activity against Cercospora

Arjun (*Terminalia aurjuna*)

Debdaru (*Polyalthea longifolia*)

Plate 3. Botanicals used to test antifungal activity against Cercospora

3.12 Intercultural operation

After emergence of seedlings, various intercultural operations were accomplished for better growth and development of plants.

3.13 Irrigation

Light over-head irrigation was provided with a watering can to the plots at flowering and pod maturity stage at 4 and 7 weeks after the seed sowing respectively. Irrigation also applied two times considering the moisture status.

3.14 Weeding

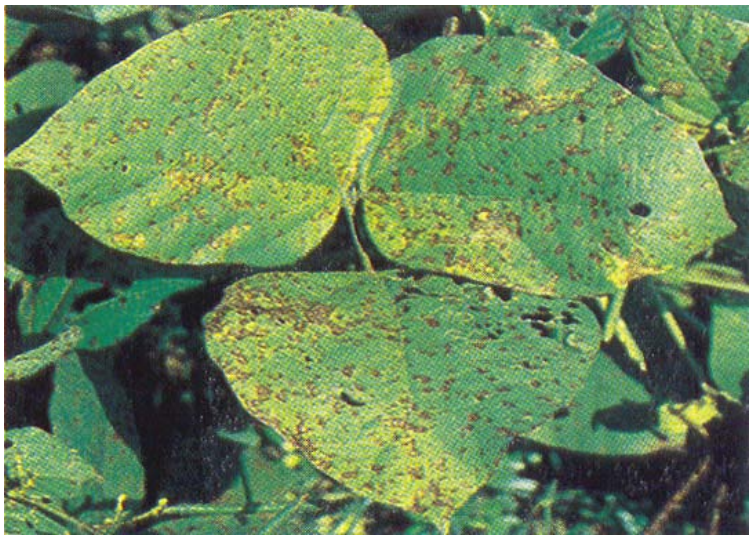
Weeding was done two times in the experimental plot. First weeding was done one month after sowing followed by another with 20 days interval.

3.15 Assessment of disease incidence

The experiment plots were examined 10 Days interval for the appearance of Cercospora leaf spot disease incidence. The incidences of disease were recorded four times. The counting was made from 30 to 60 DAS at 10 days interval, which includes the per cent plant infection at different DAS to compare with, different other treatments. The infected plants were identified by comparing it symptoms critically with those already published by Ahmed (1985). The incidence of Cercospora leaf spot was calculated as follows:

$$\% \text{ infected plants} = \frac{\text{Number of infected plant in each plot}}{\text{Total number of plants in each plot}} \times 100$$

Healthy leaf



Infected leaf

Plate 4. Healthy and Cercospora infected leaf of mungbean

Healthy Plant

Infected Plant

Plate 5. Healthy and Cercospora infected plant of mungbean

Healthy pod

Infected pod

Plate 6. Healthy and Cercospora infected pod of mungbean

3.16 Assessment of disease severity

Disease severity was recorded at 30, 40, 50 and 60 DAS by using (0-9) disease severity score Metha and Mondal(1978). Ten infected plants were selected randomly from each replicated plot. Five trifoliate leaves were identified from each selected plant for scoring the disease severity data. At 60 DAS, the severity score was made in different plants due to rouge out of the infected plants after scoring the severity data at 50 DAS. Disease severity was determined as PDI by using following formula (Krisna Prasad *et al.,* 1979).

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of total ratting}}{\text{Total number of observation} \times \text{Highest grade in the scale}} \times 100$$

The severity of Cercospora leaf spot disease was recorded following the grade as used by Metha and Mondal (1978).

Numeric score	Symptom severely on plants at maximum flowering and pod formation stage
0	No visible symptoms on leaves, plant growth, flowering and pod formation normal
1	10% leaf area infection
3	11-30% leaf area infection
5	31-50% leaf area infection
7	51-70% leaf area infection
9	71% and above leaf area infection

40% 20% 10% 5% 0%

100% 80% 75% 60% 50%

Plate 7. Showing Gradual development of the lesions and the percentage of the leaf area infected by *Cercospora* sp

3.17 Harvesting and recording of data

The crop was harvested at full ripening stage. Before harvesting 10 diseased plants (which have initially produced the symptoms) and 10 apparently healthy looking plants in each unit plots were selected randomly for the data collection of the following parameters:

i. Disease incidence (% plant infected)
ii. Disease severity (%)
iii. Number of inflorescence per plant
iv. Plant height (cm)
v. Number of primary branches per plant
vi. Number of bunches per branch
vii. Number of pod per plant
viii. Pod length (cm)
ix. Number of seed per pod
x. 1000 seed weight (g)
xi. Yield per plot (kg)
xii. Yield per hectare (tonnes)

3.18 Statistical analysis

The data obtained for different characters were statistically analyzed to find out the significance of the treatment on mungbean. The analysis of variance was performed by using MSTAT program. The significance of the difference among the treatment means was estimated by DMRT (Duncan's Multiple Range Test) at 5% level of probability (Gomez and Gomez, 1984).

RESULTS

The present experiment was conducted for the management of Cercospora leaf spot of mungbean through botanicals. Data was recorded on disease incidence, severity, yield contributing characters and yield of mungbean for different botanical extracts. The analyses of variance (ANOVA) of the data on different characters are given in Appendix IV-VII. The results have been presented and discussed, and possible interpretations have been given under the following headings:

4.1 Disease incidence (% plant infected)

Different plant extract that were used as treatment for the experiment showed for Cercospora leaf spot disease of mungbean for disease incidence (% plant infected) at 30, 40, 50 and 60 DAS (Appendix IV).

At 30 DAS, there were no statistically significant variations in Cercospora disease incidence for different treatments. The highest (1.83% infected plant) disease incidence was recorded for treatment T_5 and T_6 (Figure 1). On the other hand the lowest (1.58% infected plant) disease incidence was recorded from treatment T_2. Statistically significant variations were recorded in disease incidence for different treatments at 40 DAS.

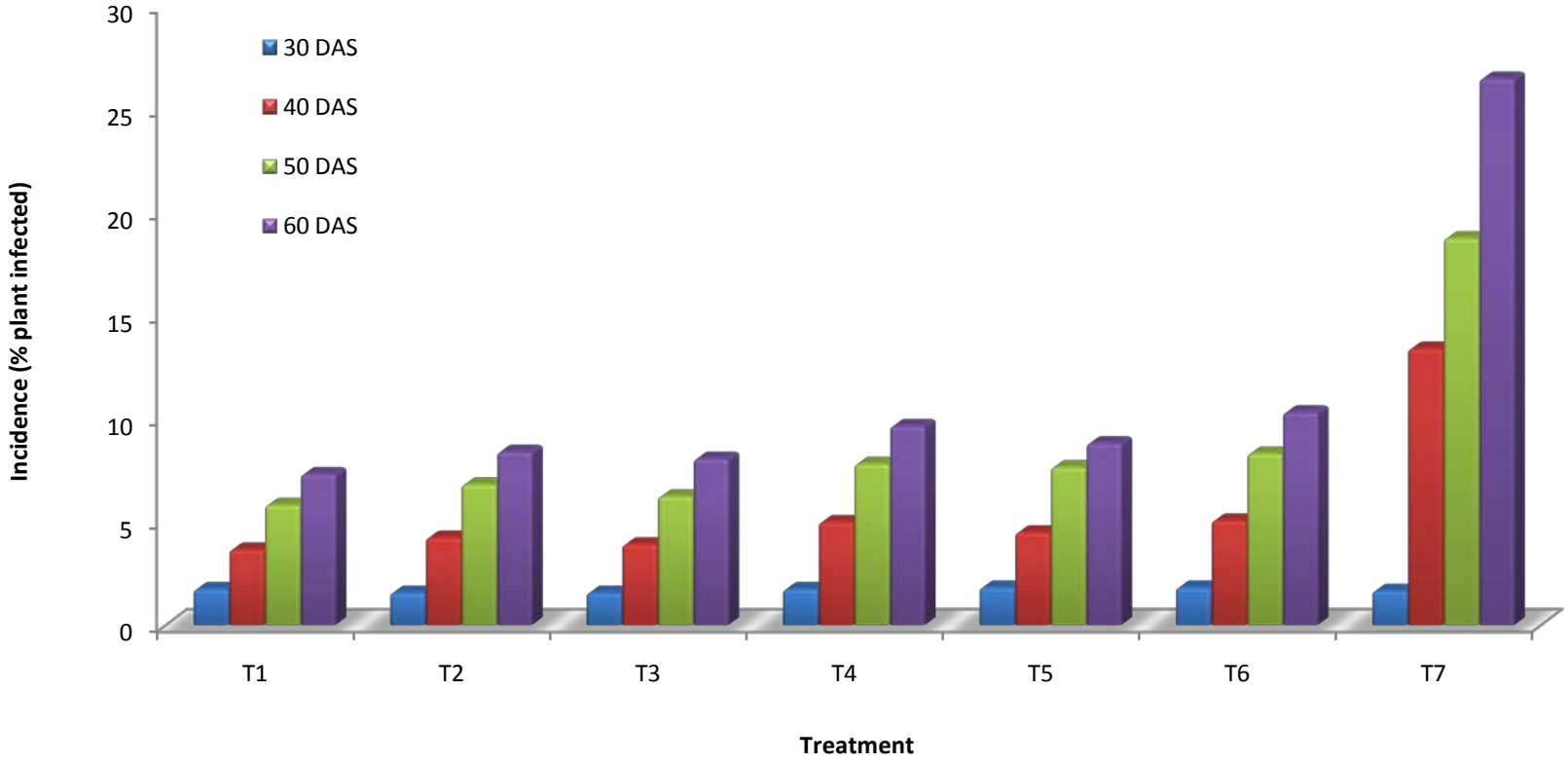


Figure 1. Incidence of Cercospora leaf spot as influenced by different botanicals used for the management of leaf spot of mungbean (cv. BARImoog-3) recorded at different dates

The highest (13.42% infected plant) disease incidence was recorded from treatment T_7 which was closely (5.08% infected plant) followed by T_6. On the other hand the lowest (3.67% infected plant) disease incidence was recorded from treatment T_1 which was statistically similar (3.92% infected plant) with treatment T_3. Statistically significant differences were recorded in disease incidence for different treatments at 50 DAS. The highest Cercospora disease incidence (18.75% infected plant) was recorded from treatment T_7 which was closely (8.33% infected plant) followed by T_6, while the lowest (5.83% infected plant) disease incidence was recorded from treatment T_1 which was statistically similar (6.25% infected plant) with treatment T_3. At 60 DAS different treatments showed a remarkable variation in Cercospora disease incidence. The highest (26.50% infected plant) disease incidence was recorded from treatment T_7 which was closely (10.33% infected plant) followed by T_6. On the other hand the lowest (7.33% infected plant) disease incidence was recorded from treatment T_1 which was statistically similar (8.08% infected plant) with treatment T_3.

4.2 Disease severity (%)

Different plant extracts used as treatment for the experiment showed for Cercospora leaf spot disease of mungbean for disease severity (0-9 scale) at 30, 40, 50 and 60 DAS (Appendix V).

There were no statistically significant variations in Cercospora disease severity (0-9 scale) for different treatments at 30 DAS. The highest (1.40) disease severity was recorded from treatment T_4 (Figure 2). On the other hand the lowest (1.18) disease severity was recorded from treatment T_3. Remarkable variations were recorded in disease severity for different treatments at 40 DAS. The highest (4.85) disease severity was recorded from treatment T_7 which was closely (2.45) followed by T_6, while the lowest (1.95) disease severity was recorded from treatment T_1 which was statistically similar (2.10) with treatment T_3. A significant difference was recorded in disease severity for different treatments at 50 DAS. The highest (10.50) disease severity was recorded from treatment T_7 which was closely (3.75) followed by T_6. On the other hand, the lowest (3.05) disease severity was recorded from treatment T_1 which was statistically similar (3.10) with treatment T_3. At 60 DAS remarkable variations were recorded in disease severity for different treatments. The highest (13.65) disease severity was recorded from treatment T_7 which was closely (5.00) followed by T_6, and the lowest (4.55) disease severity was recorded from treatment T_2 and T_3.

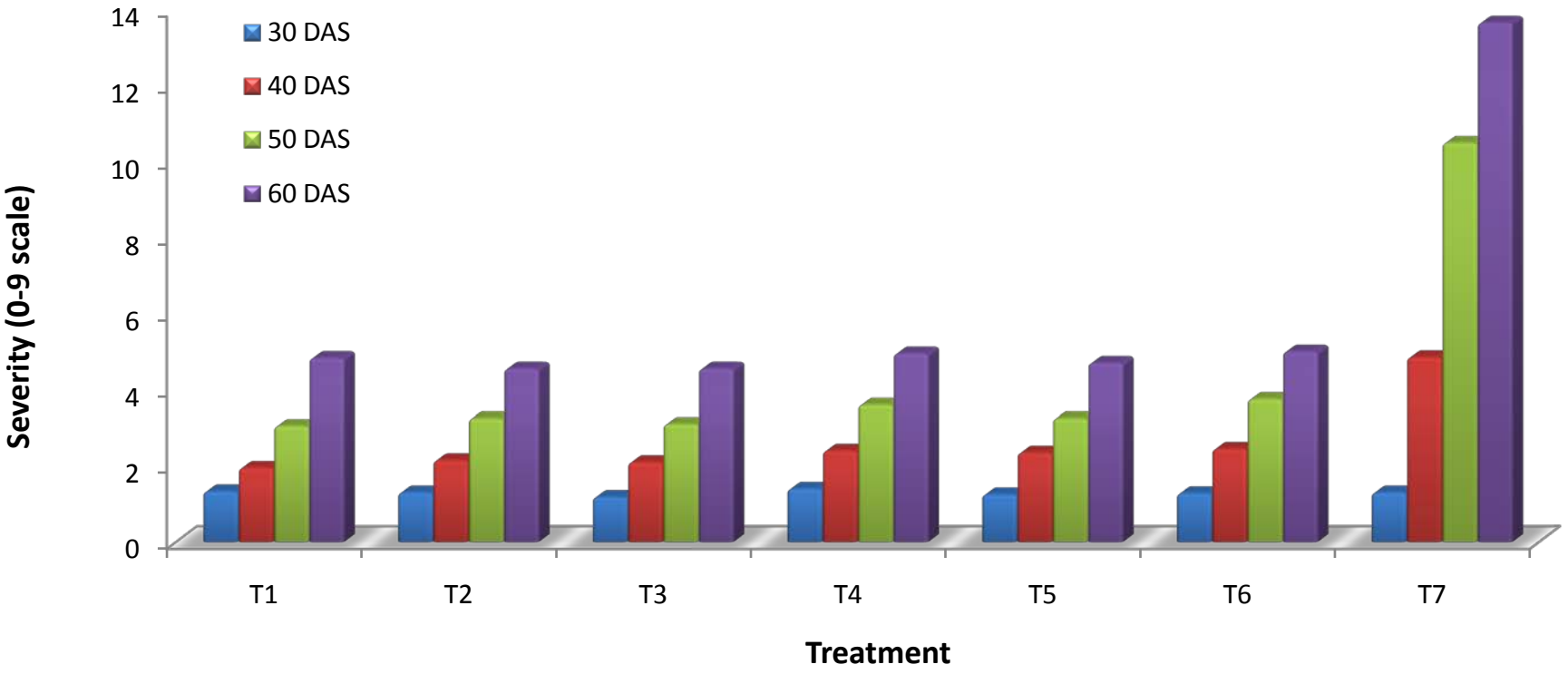


Figure 2. Severity of Cercosrpora leaf spot as influenced by different treatments used for the management of leaf spot of mungbean (cv. BARImoog-3) recorded at different dates

4.3 Number of inflorescence per plant

Number of inflorescence per plant showed an appreciable difference for different plant extracts used in this experiment (Appendix VI). The highest (13.45) number of inflorescence per plant was recorded from treatment T_1 which was closely followed (13.05) by T_3 treatment (Table 1). On the other hand the lowest (10.02) number of inflorescence per plant was recorded from the treatment T_7 which was closely followed (11.85) by T_6 treatment. Increase of number of inflorescence per plant over control performed differences for different treatments. The highest (34.23%) increase number of inflorescence per plant was recorded from treatment T_1 and the lowest (18.26%) number of inflorescence per plant was recorded from T_6 treatment.

4.4 Plant height (cm)

There was a little variation recorded for plant height due to application of different plant extracts used in this experiment for controlling Cercospora leaf spot of mungbean (Appendix VI). The tallest (51.44 cm) plant was recorded from treatment T_1 which was statistically simillar (50.05 cm, 50.82 cm, 49.87 cm, 49.86 cm, 49.19 cm respectively) with T_2, T_3, T_4, T_5, T_6.On the other the shortest (44.75 cm) plant was recorded from treatment T_7. Increase of plant height over control showed different ranges for different treatment. The highest (14.95%) increase plant height was recorded from treatment T_1 and the lowest (9.92%) was recorded from T_6 treatment.

Table 1. Number of inflorescence per plant and height of plant influenced by different treatments used for the management of Cercospora leaf spot of mungbean (cv. BARImoog-3)

Treatments	Number of inflorescence per plant	Increase of number of inflorescence per plant over control (%)	Plant height (cm)	Increase of plant height over control (%)
T_1 = Neem leaves extract (1:4 w/v)	13.45 a	34.23	51.44 a	**14.95**
T_2 = Garlic cloves extract (1:5 w/v)	12.51 bc	24.85	50.05 a	**11.84**
T_3 = Biskatali leaves extract (1:4 w/v)	13.05 ab	30.24	50.82 a	**13.56**
T_4 = Alamanda leaves extract (1:6 w/v)	12.00 cd	19.76	49.87 a	**11.44**
T_5 = Arjun leaves extract (1:4 w/v)	12.35 cd	23.25	49.86 a	**11.42**
T_6 = Debdaru leaves extract (1:5 w/v)	11.85 d	18.26	49.19 a	**9.92**
T_7 = Untreated (control)	10.02 e	--	44.75 b	--
$LSD_{(0.05)}$	0.607	--	2.166	--
CV(%)	3.36	--	2.95	--

In a column figures having dissimilar letter(s) differ significantly at 0.05 level of probability

4.5 Number of primary branches per plant

Number of primary branches per plant showed a significant difference for different plant extracts used in this experiment (Appendix VI). The highest (5.38) number of primary branches per plant was recorded from treatment T_1 which was statistically similar (5.34) with T_3 treatment (Table 2). On the other hand the lowest (3.62) number of inflorescence per plant was recorded from the treatment T_7. Increased of number of primary branches per plant over control showed differences for different treatment. The highest (48.62%) increase number of primary branches per plant was recorded from treatment T_1 and the lowest (30.11%) number of primary branches per plant was recorded from T_6 treatment.

4.6 Number of bunches per plant

Non significant variation was recorded for number of bunches per plant for different plant extracts used in this experiment for controlling Cercospora leaf spot of mungbean (Appendix VI). The highest (7.84) number of bunches per branch was recorded from treatment T_1 which was closely followed (7.71) by T_2 treatment (Table 2). On the other hand the lowest (6.61) number of bunches per plant was recorded from the treatment T_7 which was closely followed (7.00) by T_6 treatment. Increased of number of bunch per plant over control showed differences for different treatment. The highest (18.61%) increase number of bunches per plant was recorded from treatment T_1 and the lowest (5.90%) number of bunches per branch was recorded from T_6 treatment.

Table 2. Number of primary branches and number of bunch per plant influenced by different treatments used for the management of Cercospora leaf spot of mungbean (cv. BARImoog-3)

Treatments	Number of primary branches per plant	Increase of primary branches over control (%)	Number of bunches per plant	Increase of number of bunches per plant (%)
T_1 = Neem leaves extract (1:4 w/v)	5.38 a	48.62	7.84	18.61
T_2 = Garlic cloves extract (1:5 w/v)	5.00 ab	38.12	7.71	16.64
T_3 = Biskatali leaves extract (1:4 w/v)	5.34 a	47.51	7.70	16.49
T_4 = Alamanda leaves extract (1:6 w/v)	4.74 b	30.94	7.35	11.20
T_5 = Arjun leaves extract (1:4 w/v)	4.94 b	36.46	7.16	8.32
T_6 = Debdaru leaves extract (1:5 w/v)	4.71 b	30.11	7.00	5.90
T_7 = Untreated (control)	3.62 c	--	6.61	--
$LSD_{(0.05)}$	0.370	--	NS	--
CV(%)	5.18	--	7.91	--

In a column figures having dissimilar letter(s) differ significantly at 0.05 level of probability

4.7 Number of pod per plant

Number of pod per plant showed some variation for different plant extracts used in this experiment for controlling Cercospora leaf spot of mungbean (Appendix VI). The maximum (26.81) number of pod per plant was recorded from the treatment T_1 (Table 3). On the other hand the minimum (21.07) number of pod per plant was recorded in treatment T_7. Increased number of pod per plant over control showed variation for different treatment. The maximum (27.24%) increase in number of pod per plant was recorded from the treatment T_1 i. e. neem leaf extract and the minimum (15.14%) was recorded in T_6 (debdaru leaf extract) treatment.

4.8 Pod length (cm)

Significant variation was recorded for pod length in different plant extracts used in this experiment (Appendix VII). The maximum (8.56 cm) pod length was recorded from the treatment T_1 which was statistically similar (8.51 cm) with T_3 treatment (Table 3). On the other hand the minimum (6.08 cm) pod length was recorded from the treatment T_7 which was closely followed (6.85 cm) by T_6 treatment. Increased of pod length over control showed differences for different treatments in the present experiment. The maximum (40.79%) increase pod length was recorded in treatment T_1 and the minimum (12.66%) was recorded in T_6 treatment.

Table 3. Number of pod per plant and pod length influenced by different treatments used for the management of Cercospora leaf spot of mungbean (cv. BARImoog-3)

Treatments	Number of pod per plant	Increase of pod per plant over control (%)	Pod length (cm)	Increase of pod length over control (%)
T_1 = Neem leaves extract (1:4 w/v)	26.81 a	27.24	8.56 a	40.79
T_2 = Garlic cloves extract (1:5 w/v)	25.42 ab	20.65	8.04 b	32.24
T_3 = Biskatali leaves extract (1:4 w/v)	26.00 ab	23.40	8.51 a	39.97
T_4 = Alamanda leaves extract (1:6 w/v)	25.03 ab	18.79	7.01 d	15.30
T_5 = Arjun leaves extract (1:4 w/v)	25.00 ab	18.65	7.63 c	25.49
T_6 = Debdaru leaves extract (1:5 w/v)	24.26 b	15.14	6.85 d	12.66
T_7 = Untreated (control)	21.07 c	--	6.08 e	--
$LSD_{(0.05)}$	2.009	--	0.326	--
CV(%)	5.45	--	2.91	--

In a column figures having dissimilar letter(s) differ significantly at 0.05 level of probability

4.9 Number of seed per pod

A remarkable difference was recorded for number of seed per pod in different plant extracts used in this experiment (Appendix VII). The maximum (12.64) number of seed per pod was recorded for treatment T_1 which was statistically similar (12.04 and 12.00) with T_2 and T_3 treatment (Table 4). On the other hand the minimum (10.26) number of seed per pod was recorded from the treatment T_7 which was statistically similar (10.82, 10.96 and 11.00) with T_6, T_5 and T_4 treatments, respectively. Increase of number of seed per pod over control showed variation for different treatment in the present experiment. The maximum (23.20%) increased number of seed per pod was recorded from the treatment T_1 and the minimum (5.46%) was recorded in T_6 treatment.

4.10 1000 seed weight

Different plant extracts used in this experiment for controlling Cercospora leaf spot of mungbean showed variation of 1000 seed weight (Appendix VII). The maximum (27.33 g) 1000 seed weight was recorded in treatment T_1 which was statistically similar (26.15 g, 27.26 g, 26.02 g, 26 g and 26.46 g) with T_2, T_3, T_4, T_5, and T_6 treatment (Table 4). On the other hand the minimum (23.73 g) 1000 seed weight was recorded from the treatment T_7. Increases of 1000 seed weight over control in percentages showed variation for different treatment under the present experiment. The maximum (15.17%) increase 1000 seed weight was recorded from the treatment T_1 and the minimum (9.57%) was recorded from T_6 treatment.

Table 4. Number of seed per pod and 1000 seed weight influenced by different treatments used for the management of Cercospora leaf spot of mungbean (cv. BARImoog-3)

Treatments	Number of seed per pod	Increase of seed per pod over control (%)	1000 seed weight (g)	Increase of 1000 seed weight over control (%)
T_1 = Neem leaves extract (1:4 w/v)	12.64 a	23.20	27.33 a	15.17
T_2 = Garlic cloves extract (1:5 w/v)	12.04 a	17.35	26.15 a	10.20
T_3 = Biskatali leaves extract (1:4 w/v)	12.00 a	16.96	27.26 a	14.88
T_4 = Alamanda leaves extract (1:6 w/v)	11.00 b	7.21	26.02 a	9.65
T_5 = Arjun leaves extract (1:4 w/v)	10.96 b	6.82	26.00 a	9.57
T_6 = Debdaru leaves extract (1:5 w/v)	10.82 b	5.46	26.46 a	11.50
T_7 = Untreated (control)	10.26 b	--	23.73 b	--
$LSD_{(0.05)}$	0.467	--	1.262	--
CV(%)	5.51	--	3.25	--

In a column figures having dissimilar letter(s) differ significantly at 0.05 level of probability

4.11 Seed yield of mungbean

Seed yield of mungbean per plot showed a significant variation among different plant extracts for controlling Cercospora leaf spot of mungbean (Appendix VII). The maximum (1.51 kg) yield per plot was recorded from the treatment T_1 i.e. by applying neem extract which was statistically similar (1.45 kg) with T_3 treatment i. e. Biskatali leaf extracts (Table 5). On the other hand, the minimum (1.21 kg) yield per plot was recorded from the treatment T_7 where no extract was applied. Increase of yield per plot over control showed differences for treatments in the present experiment. The maximum (24.79%) increase in yield per plot over control was recorded from treatment T_1 and the minimum (13.22%) was recorded from T_6 treatment. The data of yield per plot was computed to yield per hectare. Variation of different plant extracts was also recorded from yield per hectare (Appendix VII). The maximum (1.26 tonnes) yield was recorded for treatment T_1 which was statistically similar (1.21 and 1.20 tonnes) with T_3 and T_2 treatment (Table 5). On the other hand, the minimum (1.01 tonnes) yield per hectare was recorded from the treatment T_7. Increase of yield per hectare over control showed variation for different treatment under the present experiment. The maximum (24.75%) increase yield per hectare over control was recorded from treatment T_1 and the minimum (12.87%) was recorded from T_6 treatment.

Table 5. Seed yield and increase of seed yield as influenced by different treatments used for the management of leaf spot of mungbean (cv. BARImoog-3)

Treatments	Yield (kg/plot)	Increase of yield per plot over control (%)	Yield (t/ha)	Increase of yield per hectare over control (%)
T_1 = Neem leaves extract (1:4 w/v)	1.51 a	24.79	1.26 a	24.75
T_2 = Garlic cloves extract (1:5 w/v)	1.44 b	19.01	1.20 ab	18.81
T_3 = Biskatali leaves extract (1:4 w/v)	1.45 ab	19.83	1.21 ab	19.80
T_4 = Alamanda leaves extract (1:6 w/v)	1.42 bc	17.36	1.18 b	16.83
T_5 = Arjun leaves extract (1:4 w/v)	1.40 bc	15.70	1.17 b	15.84
T_6 = Debdaru leaves extract (1:5 w/v)	1.37 c	13.22	1.14 b	12.87
T_7 = Untreated (control)	1.21 d	--	1.01 c	--
$LSD_{(0.05)}$	0.066	--	0.066	--
CV(%)	3.41	--	3.41	--

In a column figures having dissimilar letter(s) differ significantly at 0.05 level of probability

DISCUSSION

Cercospora leaf spot is a serious disease of mungbean. It may be considered as one of the chief limiting factors which is widely distributed all over the country where mungbean is cultivated. The best measure to control this disease could be developing resistant high yielding cultivars. But so far, the objective of incorporating sustainable resistance could not be achieved. Moreover, an apparently resistant cultivar developed at one part of the country appeared to be fail in retaining the resistance when grown in another Agro Ecological Zone (AEZ).

Different approaches was tried to control the *Cercospora* leaf spot, which included (i) spray of chemical fungicides, (ii) spray of different plant extracts (iii) use of resistant variety and different cultural management options. Chemical fungicides are effective in some cases but hazards to human health causing environment pollution. Attempt is being made, in the present world, to use plant extracts to control plant diseases. Fortunately some plant extracts have been used very effectively in controlling different fungal diseases (Anon., 1984) .

In the present study, different plant extracts used for controlling Cercospora leaf spot was studied under field conditions. It is evident that some of the treatments showed significant effect in respect of reducing

disease incidence (% infected plant) at 30, 40, 50 and 60 DAS. It has been observed that neem leaves extract resulted significant reduction of Cercospora leaf spot of mungbean over untreated (control) (Anon., 1984; BARI, 2007). Fakir (2000); Afzal *et al*. (1999); Bakr (1994); Razzaque and Hossain (1991) under took research with different plant extracts to find out their antifungal potentiality. Miah *et al*. (1990) and Ahmed (1985) reported that neem extract had potential for controlling Cercospora leaf spot in mungbean.

It is evident that the treatments showed significant effect in respect of disease severity (0-9 scale) at 30, 40, 50 and 60 DAS. It has been observed that neem leaves extract resulted significant reduction of Cercospora leaf spot of mungbean over untreated (control) (BARI, 2007; Khan, 1981; Mehta and Mondal 1978). The lowest disease severity was observed with different plant extracts. Among the different plant extracts neem extracts was most effective. Bishkathali and garlic were also effective than alamonda, arjun and debdaru leaves extracts. Dharam and Sharma (1985), Mondal, 1978, Alpana and Singh (1994) and Ahmed and Sultana (1984) used neem oil and found that 100% effective against the growth of disease of anthracnose and stem rot rot jute. Islam *et al*. (2006) found a significant reduction of the diseases severity of leaf blight of wheat by seed treatment with garlic and bishkatali. The works of Achimu

and Schloesser (1992) and others confirmed that neem leaf have high antifungal properties. Achimu and Schlosser (1992) carried out an experiment to find out the effect of neem seed extracts against downy mildew (*Plasmopara viticola*) of grapevine. They found that raw neem seed extract and commercial neem products had high (80-90%) antifungal properties against *Plasmopara viticola*.

In the present experiment, it has been observed that mungbean plant treated with plant extracts showed a significant effect on number of inflorescence per plant and plant height. The highest number of inflorescence per plant and plant height was recorded in neem leaves extract where the lowest value was recorded in untreated (control) condition. Nariani (1960) reported that neem extracts had significant influence on controlling yellow mosaic viruses in mungbean and that creates a favorable condition for plant growth which lead to produce maximum number of inflorescence per plant and also produce the tallest plant with maximum photosynthesis. Williams *et al*. (1968), Poehlman (1991); Roy and Malathi, (2001) reported the similar effect on number of inflorescence per plant and plant height of mungbean. *Vigna radiata* plants in pots, kept in the field, were protected against natural viral infections by spraying with leaf extract of *C. aculeatum,* together with soil amendment with dry leaf powder or fresh extract by Barman and Das

(1996). Unsprayed plants developed severe symptoms of mung bean yellow mosaic bigeminivirus while treated plants were either asymptomatic or showed only very mild symptoms.

In the present experiment, it has been observed that mungbean plant treatment with plant extracts showed a significant effect on number of primary branches per plant, number of pod per plant, pod length and number of seed per pod. The maximum value for this parameters was recorded for the application of neem leaf extracts than the control but all of the plant extract was superior than the untreated (control) condition. Mian (1976); Jalaluddin and Shaik (1981); Shyam *et al*. (2004) reported that plant extracts was more effective control measure than the other options for cost effective production. Further works of Singh Dwvedi (1987); Tariq and Magee (1990); Lakshmanan *et al.,* (1990) supported the earlier findings and recommended the use of garlic as an antifungal agent. Dubey and Dwivedi (1991) reported that fungistatic properties of extracts of leaves, bulb of onion and garlic and fruit, bark of *Allium cepa* against vegetative growth, *Sclerotia* variability of *Macrophomina phaseolina*. They observed that all the extracts inhibited growth but garlic bulb extract was more effective than other extracts employed in the tests. Tewari and Mandakini (1991) reported that extracts of *Piper betle*, *Ocimum sanctum*, *Nyctanthes arbortristis* and *Citrus lemon* were effective in reducing the radial growth of *Pyricularia oryzae*, *C. miyabeanus* and *Rhizoctonia solani* in vitro, with extracts of *P. betle*,

follwed by *O. sanctum* the most effective. Mohanty *et al*. (1995) observed that garlic bulb extract (1:1) and allanmanda leaf extract sprays in the field reduced phomopsis blight and fruit rot by 66% and 75%, respectively.

In the present experiment, it has been observed that mungbean plant treatment with plant extracts showed to have some effect on 1000 seed weight and significant effect on yield per plot and hectare. The highest yield was recorded from the plot where plant extracts were applied. Among the different plant extracts neem leaves extracts was more effective and bishkathali also had similar effect. Shyam *et al*. (2004) successfully controlled MYMV the application of the aqueous root extract of *Boerhaavia diffusa*. Treatments were administered weekly, as foliar sprays, at a concentration of 10%, commencing from the seedling stage. Six sprays of *B. diffusa* root extract were found most effective. Islam *et al*. (2006) also informed that seed treatment with bishkathali extract increased 29.74% yield of wheat over untreated (control).

In promoting yield contributing parameters and yield as observed here as number of inflorescence per plant, plant height, number of primary branches per plant, number of pod per plant, pod length, number of seed per pod, 1000 seed weight, yield per plot and hectare, the performance of treatments neem leaves extract was more effective than the other leaves extract. But any of the plant extracts improved the yield contributing parameters and also yield.

SUMMARY AND CONCLUSION

The present study was conducted for the management of Cercospora leaf spot of mungbean through botanicals in the farm of Bangladesh Agricultural Research Institute, Joydevpur, Gazipur, Bangladesh during the period from March to July 2007. The experiment consists of 7 treatments such as T_1 = Neem leaves extract (1:4 w/v); T_2 = Garlic cloves extract (1:5 w/v); T_3 = Biskatali leaves extract (1:4 w/v); T_4 = Alamanda leaves extract (1:6 w/v); T_5 = Arjun leaves extract (1:4 w/v); T_6 = Debdaru leaves extract (1:5 w/v) and T_7 = Untreated (control). The experiment was laid out in Randomized Complete Block Design. Data on different disease incidence, severity, yield contributing characters and yield of mungbean for different botanical extracts were recorded.

The highest (1.83% infected plant) disease incidence was recorded for treatment T_5 and T_6 and the lowest (1.58% infected plant) disease incidence was recorded for treatment T_2 at 30 DAS. At 40 DAS the highest (13.42% infected plant) disease incidence was recorded for treatment T_7, while the lowest (3.67% infected plant) disease incidence was recorded for treatment T_1. At 50 DAS the highest (18.75% infected plant) Cercospora disease incidence was recorded for treatment T_7, while the lowest (5.83% infected plant) disease incidence was recorded in treatment T_1 i.e. application of neem leaf extract. At 60 DAS the highest

(13.42% infected plant) disease incidence was recorded in treatment T_7 and the lowest (3.67% infected plant) disease incidence was recorded in treatment T_1.

At 30 DAS the highest (1.40) disease severity was recorded for treatment T_4 i.e. alamanda leaf extract and the lowest (1.18) disease severity was recorded for treatment T_3 i.e. application of Biskatali leaf extract. At 40 DAS the highest (4.85) disease severity was recorded for treatment T_7 where no extract was applied, while the lowest (1.95) disease severity was recorded for treatment T_1. At 50 DAS the highest (10.50) disease severity was recorded for treatment T_7 and the lowest (3.05) disease severity was recorded for treatment T_1. At 60 DAS the highest (13.65) disease severity was recorded for treatment T_7 and the lowest (4.55) disease severity was recorded for treatment T_2 and T_3 i.e. garlic extract and Biskatali leaf extract, respectively.

The highest (13.45) number of inflorescence per plant was recorded for treatment T_1 which was closely followed (13.05) treatment T_3 and the lowest (10.02) number of inflorescence per plant was recorded in the treatment T_7. The highest (34.23%) increase number of inflorescence per plant was recorded in treatment T_1 and the lowest (18.26%) number of inflorescence per plant was recorded in T_6. The tallest (51.44 cm) plant was recorded in treatment T_1, while the shortest (44.75 cm) plant was

recorded in the treatment T_7. The highest (14.95%) increase of plant height was recorded in treatment T_1 and the lowest (9.92%) increase of plant height was recorded in T_6. The highest (5.38) number of primary branches per plant was recorded in treatment T_1 and the lowest (3.62) number of number of primary branches per plant was recorded in the treatment T_7. The highest (48.62%) increase number of primary branches per plant was recorded in treatment T_1 and the lowest (30.11%) number of primary branches per plant was recorded in T_6 treatment. The highest (7.84) number of bunches per plant was recorded in treatment T_1, while the lowest (6.61) number of bunches per plant was recorded in the treatment T_7. The highest (18.61%) increase in number of bunches per plant was recorded in treatment T_1 and the lowest (5.90%) bunches per branch was recorded in T_6 treatment.

The maximum (26.81) number of pod per plant was recorded for treatment T_1 and the minimum (21.07) number of pod per plant was recorded in the treatment T_7. The maximum (27.24%) increase in number of pod per plant was recorded in treatment T_1 and the minimum (15.14%) number of pod per plant was recorded in T_6. The maximum (8.56 cm) pod length was recorded in treatment T_1 and the minimum (6.08 cm) pod length was recorded in the treatment T_7. The maximum (40.79%) increase pod length was recorded in treatment T_1 and the minimum (12.66%) was recorded in T_6 treatment. The maximum (12.64) number of seed per pod

was recorded in treatment T_1 and the minimum (10.26) number of seed per pod in the treatment T_7. The maximum (23.20%) increase number of seed per pod was recorded in treatment T_1 and the minimum (5.46%) was recorded in T_6 treatment. The maximum (27.33 g) 1000 seed weight was recorded in treatment T_1 and the minimum (23.73 g) 1000 seed weight was recorded in the treatment T_7. The maximum (15.17%) increase 1000 seed weight was recorded in treatment T_1 and the minimum (9.57%) in T_5 treatment.

The maximum (1.51 kg) yield per plot was recorded in treatment T_1 and the minimum (1.21 kg) yield per plot in the treatment T_7. The maximum (24.79%) increase in yield per plot over control was recorded in treatment T_1 and the minimum (13.22%) in T_6 treatment. Similarly, the maximum (1.26 tonnes) yield per hectare was computed in treatment T_1, while the minimum (1.01 tonnes) yield per hectare was recorded in the treatment T_7. The maximum (24.75%) increase yield per hectare over control was recorded in treatment T_1 and the minimum (12.87%) was recorded in T_6 treatment. Among the different treatment neem leaves extracts was most effective than other treatment. Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Other plant extracts may be explored in the future study;
2. Further study may be undertaken to spell out the extract concentration.

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APPENDICES

Appendix I. Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from March to July 2007

Month	Air temperature (^{0}C)			RH (%)	Total rainfall (mm)
	Maximum	Minimum	Mean		
March 2007	31.25	21.55	26.40	74.65	35
April 2007	32.98	23.72	28.35	88.24	65
May 2007	34.00	24.65	34.33	79.55	155
June 2007	33.85	26.15	30.0	69.05	184
July 2007	34.20	24.50	29.35	89.5	281

Appendix II. Results of mechanical and chemical analysis of soil of the experimental plot

Mechanical analysis

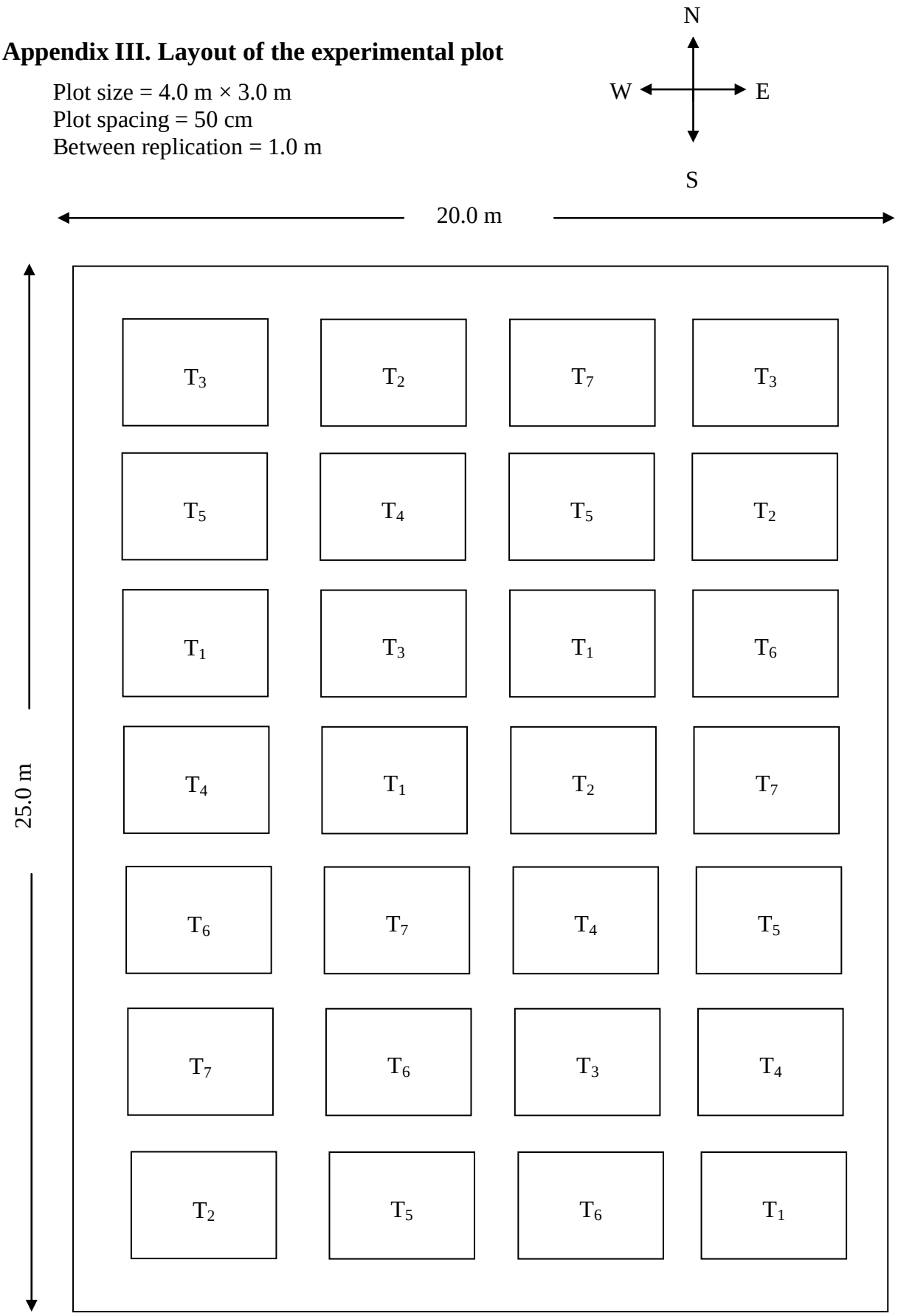
Constituents	Percent
Sand	32.45
Silt	61.35
Clay	6.10
Textural class	Silty loam

Chemical analysis

Soil properties	Amount
Soil pH	6.15
Organic carbon (%)	1.32
Total nitrogen (%)	0.075
Available P (ppm)	19.5
Exchangeable K (%)	0.2

Appendix III. Layout of the experimental plot

Plot size = 4.0 m × 3.0 m
Plot spacing = 50 cm
Between replication = 1.0 m



Appendix IV. Analysis of variance of the data on incidence of Cercospora as influenced by different treatments used for the management of leaf spot of mungbean (cv. BARImoog-3)

Source of variation	Degrees of freedom	Mean square			
		Incidence (% plant infected)			
		30 DAS	40 DAS	50 DAS	60 DAS
Replication	3	0.018	0.121	0.161	0.014
Treatment	6	0.045	47.516**	80.406**	183.414**
Error	18	0.043	0.538	0.464	0.935

**: Significant at 1% level of probability;

Appendix V. Analysis of variance of the data on Severity of Cercospora as influenced by different treatments used for the management of leaf spot of mungbean (cv. BARImoog-3)

Source of variation	Degrees of freedom	Mean square			
		Severity (0-9 scale)			
		30 DAS	40 DAS	50 DAS	60 DAS
Replication	3	0.019	0.015	0.006	0.237
Treatment	6	0.018	4.041**	29.611**	45.249**
Error	18	0.058	0.043	0.137	0.183

**: Significant at 1% level of probability;

Appendix VI. Analysis of variance of the data on plant height, number of primary branches per plant, number of pod per plant and pod length as influenced by different treatments used for the management of Cercospora leaf spot of mungbean (cv. BARImoog-3)

Source of variation	Degrees of freedom	Mean square				
		Number of inflorescence per plant	Plant height (cm)	Number of primary branches per plant	Number of bunch per plant	Number of pod per plant
Replication	3	0.114	0.156	0.010	0.102	6.134
Treatment	6	4.876**	19.151**	1.393**	1.895	13.449**
Error	18	0.167	2.125	0.062	1.662	1.829

**: Significant at 1% level of probability;

Appendix VII. Analysis of variance of the data on number of seed per pod, 1000 seed weight, yield per plot and per hectare as influenced by different treatments used for the management of Cercospora leaf spot of mungbean (cv. BARImoog-3)

Source of variation	Degrees of freedom	Mean square				
		Pod length (cm)	Number of seed per pod	1000 seed weight (g)	Yield (kg/plot)	Yield (t/ha)
Replication	3	0.010	0.002	0.744	0.002	0.001
Treatment	6	3.418**	0.716*	5.743**	0.036**	0.025**
Error	18	0.048	0.099	0.722	0.002	0.002

*: Significant at 5% level of probability; **: Significant at 1% level of probability;

Appendix VIII. Incidence of Cercospora leaf spot as influenced by different botanicals used for the management of leaf spot of mungbean (cv. BARImoog-3)

Treatments	Incidence (% plant infected)			
	30 DAS	40 DAS	50 DAS	60 DAS
T_1 = Neem leaves extract (1:4 w/v)	1.75	3.67 c	5.83 d	7.33 d
T_2 = Garlic cloves extract (1:5 w/v)	1.58	4.25 bc	6.83 cd	8.42 cd
T_3 = Biskatali leaves extract (1:4 w/v)	1.58	3.92 bc	6.25 d	8.08 d
T_4 = Alamanda leaves extract (1:6 w/v)	1.75	5.00 b	7.83 bc	9.67 bc
T_5 = Arjun leaves extract (1:4 w/v)	1.83	4.50 bc	7.67 bc	8.83 bcd
T_6 = Debdaru leaves extract (1:5 w/v)	1.83	5.08 b	8.33 b	10.33 b
T_7 = Untreated (control)	1.67	13.42 a	18.75 a	26.50 a
$LSD_{(0.05)}$	NS	1.090	1.012	1.436
CV(%)	12.14	12.89	7.75	8.55

In a column figures having similar letter(s) don't differ statistically while figures having dissimilar letter(s) differ significantly at 0.05 level of probability

Appendix IX. Severity of Cercosrpora leaf spot as influenced by different treatments used for the management of leaf spot of mungbean (cv. BARImoog-3)

Treatments	Severity (0-9 scale)			
	30 DAS	40 DAS	50 DAS	60 DAS
T_1 = Neem leaves extract (1:4 w/v)	1.33	1.95 d	3.05 c	4.83 b
T_2 = Garlic cloves extract (1:5 w/v)	1.30	2.15 bcd	3.25 bc	4.55 b
T_3 = Biskatali leaves extract (1:4 w/v)	1.18	2.10 cd	3.10 c	4.55 b
T_4 = Alamanda leaves extract (1:6 w/v)	1.40	2.40 bc	3.60 bc	4.95 b
T_5 = Arjun leaves extract (1:4 w/v)	1.25	2.35 bc	3.25 bc	4.70 b
T_6 = Debdaru leaves extract (1:5 w/v)	1.28	2.45 b	3.75 b	5.00 b
T_7 = Untreated (control)	1.30	4.85 a	10.50 a	13.65 a
$LSD_{(0.05)}$	NS	0.308	0.550	0.636
CV(%)	18.66	7.96	8.48	7.10

In a column figures having dissimilar letter(s) differ significantly at 0.05 level of probability